EVALUATION OF PHOTODYNAMIC THERAPY AS AN ADJUNCT TO SRP IN THE MANAGEMENT OF CHRONIC PERIODONTITIS PATIENTS
A RANDOMIZED CLINICAL CONTROLLED STUDY

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BRANCH II

PERIODONTOLOGY

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CERTIFICATE – I

This is to certify that **Dr. A.RAMSUNDAR (Reg No:241613553)** Post Graduate student (2016-2019) in the Department of Periodontology, CSI College of Dental Sciences and Research, has done this dissertation titled **"EVALUATION OF PHOTODYNAMIC THERAPY AS AN ADJUNCT TO SRP IN THE MANAGEMENT OF CHRONIC PERIODONTITIS PATIENT- A RANDOMIZED CLINICAL CONTROLLED STUDY "**under our guidance and supervision in partial fulfillment of the regulations laid down by **The Tamilnadu Dr. M.G.R. Medical University**, Chennai – 600032 for **M.D.S.,** (Branch –II) **Periodontology** degree examination.

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DR A.RAMSUNDAR

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ABBREVIATIONS

LIST OF ABBREVIATIONS

aPDT	Antimicrobial photodynamic therapy
BOP	Bleeding on probing
CAL	Clinical attachment level
DNA	Deoxyribonucleic acid
FMBS	Full mouth bleeding scores
FMPS	Full mouth plaque scores
F.nucleatum	Fusobacterium nucleatum
GCF	Gingival crevicular fluid
GI	Gingival index
GR	Gingival recession
GM-CSF	Granulocyte monocyte – colony stimulating factor
IL	Interleukin
KTP	Potassium titanyl phosphate
LDD	Local drug delivery

LED	Light emitting diode
LLLT	Low level laser therapy
MB	Methylene blue
mW	MilliWatt
min	Minutes
Nd:YAG	Neodymium doped : Yttrium Aluminium Garnet
nm	Nanometer
PCR	Polymerase chain reaction
PD	Probing depth
PI	Plaque index
PPD	Probing pocket depth
P.gingivalis	Porphyromonas Gingivalis
Pa	Photoablative
PMN	Polymorphonuclear neutrophils
RAL	Relative attachment level

ROS	Reactive oxygen species
RANKL	Receptor activator of nuclear factor kappa-B ligand
S	Singlet state
S*	Excited singlet state
s	Seconds
SD	Standard deviation
SRP	Scaling and root planning
T	Excited triplet state
TBO	Toluidine blue
TNF - α	Tumour necrosis factor – α
TGF- β	Transforming growth factor – β
IO2	Singlet oxygen
OPG	Osteoprotegerin

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ABSTRACT

ABSTRACT

Aim

The aim of this study is to evaluate the efficiency of photodynamic therapy, when used as an adjunct to scaling and root planing, in chronic Periodontitis patients.

Materials and Methods

A split mouth design was conducted in 32 patients with Chronic Periodontitis. The control site underwent scaling and root planing and the experimental site were additionally treated with Photodynamic therapy. Clinical parameters namely, Plaque index, Gingival index, Papillary bleeding index, Probing pocket depth, Clinical Attachment level were recorded at baseline, 1 month, 3 month and 6 month post operatively.

Results

Both treatment strategies showed significant improvement in Plaque index, Gingival index, papillary bleeding index, Probing pocket depth and Clinical Attachment levels. At study termination, Photodynamic therapy implemented treatment strategy resulted in additional improvement in the clinical parameters like plaque index, gingival index and Probing pocket depth, Papillary Bleeding Index and gain in Clinical Attachment Level at 6 month.

Conclusion

These findings suggest that a Photodynamic therapy implemented treatment strategy along with scaling and root planing may improve the clinical outcome for the treatment of chronic Periodontitis in comparison to scaling and root planing alone.

Key Words: Periodontitis, Scaling and Root planing, Photodynamic therapy

INTRODUCTION

INTRODUCTION

Periodontitis is a multifactorial disease with a complex etiology.[67] The main objective of periodontal therapy is to eliminate deposits of bacteria by removing the supra gingival and sub gingival biofilms.[25] In the treatment of periodontally involved teeth, current concepts are based on mechanical scaling and root planing to remove bacterial deposits, calculus, and cementum contaminated by bacteria and endotoxins.[73,98] Conventional treatment approaches such as scaling and root planing does not completely eradicate the periodontal pathogens.[1]

Some therapeutic adjunctive, such as systemic and local antibiotics, have been used in cases not responding to conventional treatments.[9, 37,101] Use of systemic antimicrobials brings undesirable side effects like the emergence of resistant micro organisms and a shift in the micro flora after extended use, which limits the use of antimicrobials.[68, 78, 83, and 84]

Recent advances in technology have led to a constant drive to develop novel approaches for the treatment of periodontal diseases. The need to find more optimal treatment protocols for periodontal disease is a long-term goal for periodontal researchers and clinicians. A novel non invasive photochemical approach for infection control, namely photodynamic therapy, has received much attention in the treatment of periodontitis.[98]

Photodynamic therapy (PDT) is a new type of noninvasive phototherapy for bacterial elimination in dentistry, which uses low-level laser light and selectively targets the bacteria without potentially damaging the host

tissues. Photodynamic therapy is also known as photo radiation therapy, phototherapy, or photo chemo –therapy.[51] It was introduced in medical therapy in 1904. It is based on the principle that a Photosensitizer (i.e. a photo activatable substance) binds to the target cells (i.e. bacteria) and can be activated by light of a suitable wavelength in the presence of oxygen.[51, 104] The exposure of the Photosensitizer to light results in the formation of reactive oxygen species (ROS), causing localized photo damage and cell death. Clinically, this reaction is cytotoxic and vasculotoxic.[88] The oral cavity is especially suitable for photodynamic therapy (PDT) because it is relatively accessible to illumination.[51, 104]


AIM

AIM OF THE STUDY

The aim of this study is to evaluate the efficiency of photodynamic therapy, when used as an adjunct to scaling and root planing, in chronic periodontitis patients.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

IJ Walsh et al (2003)[43] in his Journal "The current status of laser application in dentistry" stated that Photo activated dye techniques have been developed which use low power lasers to elicit chemical reaction. This can be used to disinfect root canals, periodontal pockets, and sites of peri-implantitis. The author also suggested that specific laser technologies will become an essential component of contemporary dental practice over the next decade.

Ishikawa I et al (2004)[46] Enumerated different types of lasers used in dentistry such as Neodymium: Yttrium–Aluminum: Garnet (Nd: YAG), carbon dioxide (CO2) laser for the soft tissue treatment in oral cavity.

Ricardo R.A Hayek et al (2005)[82] conducted a study to compare the effects of photodynamic therapy (PDT) and conventional technique on microbial reduction in ligature-induced peri-implantitis in dogs. The authors stated that the selective action of PDT, which does not affect normal cells, is one of the most important characteristics of this therapy.

Ambrosini P et al (2005)[8] Evaluated the effectiveness of Nd:YAG laser for the initial treatment of adult Periodontitis and concluded that there was no statistically significant difference concerning clinical data between test and control groups. T.*forsythensis* was the organism found most numerous in both groups.

Iriana Carla et al (2005)[44] conducted a study to evaluate the antimicrobial effect of Toluidine blue O (TBO), in combination with either a

Helium/Neon (HeNe) laser or a light-emitting diode (LED), on the viability and architecture of Streptococcus *mutans* biofilms. The author concluded that Photodynamic therapy may be a useful approach in the treatment of dental plaque-related diseases.

Simon Wood et al (2006)[90] conducted a study to compare the bacterial killing efficacy of erythrosine with that of two well-characterized photosensitizes methylene blue (MB) and photofrin. They also determined the localization of the Photosensitizer within biofilms using confocal laser scanning microscopy (CLSM). The CLSM results showed that erythrosine is taken up into *S. mutans* biofilms, where it is associated with the biomass of the biofilms rather than the fluid filled channels and voids. Comparison of the cell killing efficacy of erythrosine in *S. mutans* biofilms of different ages showed that erythrosine was 1-2 log more effective at killing biofilms bacteria than photofrin and 0.5 – 1 log more effective than Methylene blue. The authors thus concluded that PDT using erythrosine as Photosensitizer shows excellent potential as a treatment for oral plaque biofilms.

Almeida et al (2007)[26] evaluated the effect of photodynamic therapy (PDT) with 100μg/ml methylene blue and 685nm low intensity laser, on the progression of experimentally induced periodontal disease in Wistar rats. The results showed significantly less than bone loss radio graphically in PDT group compared to control group at 5 and 15 days postoperatively but no significant difference in bone loss at 30 days. The results suggested that PDT produced transiently reduced the periodontal tissue destruction.

Momchilova N., et al (2007)[64] Developed Low-Cost Photodynamic Therapy Device using delta aminolevulinic acid/protoporphyrin IX (5-

ALA/PpIX) and light-emitting diodes at 405 nm for fluorescence excitation of PpIX. The authors found it to be effective in detection and treatment of basal cell carcinoma lesions.

Christodoulides N et al (2008)[23] in their study concluded that the additional application of a single episode of PDT to scaling and root planing failed to result in an additional improvement in terms of Pocket Depth reduction and Clinical Attachment Level gain, but it resulted in a significantly higher reduction in bleeding scores compared to scaling and root planing alone.

Braun et al (2008)[17] conducted a split mouth clinical trial to evaluate the effect of adjunctive antimicrobial photodynamic therapy (aPDT) in patients with untreated chronic Periodontitis. The results of this study imply, clinical outcomes of conventional sub gingival debridement can be improved by adjunctive aPDT.

Fontana et al (2009)[32] investigated the effects of photodynamic therapy (PDT) using methylene blue on human dental plaque microorganisms in the planktonic phase and in biofilms. The results of this study imply the fact that oral bacteria in biofilms are affected less by PDT than bacteria in the planktonic phase.

Braham et al (2009)[16] developed a model that could simultaneously compare protease inactivation to P.*gingivalis.* The results showed that a single aPDT treatment in vitro potently inactivated protease activity reduced the viability of P. *gingivalis* and also potently and functionally inactivated IL-1β and TNF-α. They concluded that aPDT treatment may augment periodontal

treatment by increasing bacterial killing, inactivating bacterial virulence factors and inactivating host cytokines that impair periodontal healing.

Al-Zaharani et al (2009)[7] examined the effects of the adjunctive use of photodynamic therapy (PDT) on the periodontal status and glycemic control in patients with type 2 diabetes mellitus and moderate to severe chronic periodontitis. The results of this study indicated that PDT does not benefit conventional nonsurgical periodontal therapy in patients with diabetes.

Polansky et al (2009)[72] conducted a study to investigate both the clinical effects and the bactericidal potential of PDT applied in conjunction with conventional ultrasonic treatment in patients with chronic periodontitis. The results of this study showed a significant reduction in all the clinical parameters and Porphyromonas *Gingivalis* in both the groups with insignificant intergroup difference. The results imply that application of a single cycle of PDT was not effective as an adjunct to ultrasonic periodontal treatment in patients with chronic periodontitis.

Sigusch et al (2010)[89] evaluated the clinical and microbiological effect of photodynamic therapy (PDT) in Fusobacterium *nucleatum* infected patients with chronic periodontitis. The results implied that the adjuvant application of the described PDT method is appropriate to reduce periodontal inflammatory symptoms and to successfully treat infection with Fusobacterium *nucleatum.*

Yogesh Doshi et al (2010)[110] in his review article to evaluate the effectiveness of photodynamic therapy (PDT) for treatment of periodontitis stated that, the application of photodynamic therapy in management of periodontal diseases is very valuable, when combined with nonsurgical

periodontal therapy. He concluded that proper clinical application of photodynamic therapy will help patients who are systemically compromised and cannot undergo surgical therapy.

Lui et al (2011)[55] designed a clinical trial to evaluate the effects of a combination of photodynamic therapy (PDT) with 1% methylene blue and 940nm low-level laser therapy (LLLT) as an adjunct to nonsurgical treatment in patients with chronic Periodontitis. The results of this study suggest that a combined course of PDT with LLLT could be a beneficial adjunct to nonsurgical treatment of Chronic Periodontitis on a short-term basis.

Rafael Celestino et al (2011)[79] in a case report used photodynamic therapy as an adjuvant to periodontal treatment in patients with Down syndrome. The result of this study showed the use of photodynamic therapy with methylene blue dye 0.01% proved to be an effective adjuvant in periodontal therapy with manual debridement, accelerating the process of tissue regeneration, decontamination, reduction of pain and significant improvement of parameters of periodontal health in Down syndrome. He concluded that it is important to the knowledge of dentists on new therapies that reduce the use of systemic medications and their adverse effects on dentistry for patients with special needs.

Giannelli et al (2012)[37] in a split mouth study evaluated the benefits of combination of SRP and sequential photoablative and photodynamic treatments over SRP alone in patients with chronic periodontitis. The results indicated that the laser + SRP therapy yielded a significant reduction in Probing pocket depth, Clinical attachment level and Bleeding on probing as

well as in bacterial contamination, especially spirochetes. They concluded that diode lasers used sequentially in photoablative and photodynamic modes as adjuncts to conventional scaling and root planing may be considered valuable tools for the treatment of Chronic Periodontitis.

PS Thakuri et al (2012)[74] proposed the use of blue light emitting diodes (LEDs) as the light source and Riboflavin as Photosensitizer for in vitro killing of Staphylococcus *aureus* and Pseudomonas *aeruginosa.* The result of this study showed that the Combination of blue LEDs and Riboflavin in PDT against these bacterial species has been successful in-vitro. Therefore, PDT has promising applications in the process of treating superficial wound infections.

Berakdar et al (2012)[12] examined the added efficacy of photodynamic therapy (PDT) on scaling and root planing (SRP) in patients with chronic Periodontitis in a split mouth study. The results of this study demonstrated SRP in combination with PDT to be effective than SRP alone and is therefore suitable as an adjuvant therapy to the mechanical debridement of the periodontal pockets in patients with chronic Periodontitis.

Agnes Roberta Scwingel et al (2012)[2] conducted a study to evaluate the antimicrobial Photodynamic Therapy in the Treatment of Oral Candidiasis in HIV-Infected Patient. He compared application of fluconazole, Low level laser therapy (LLLT) and antimicrobial Photodynamic Therapy (aPDT) in treatment of Oral Candidiasis in HIV infected Patients. The results showed that fluconazole was effective but did not prevent the return of the Candidiasis in short-term. LLLT did not show any reduction on Candida spp. aPDT

eradicated 100% of the colonies of this fungus and the patients did not show recurrence of Candidiasis up to 30 days after the irradiation. The author suggested that aPDT is a potential approach to oral Candidiasis treatment in HIV-infected patients.

Sudhakara Reddy et al (2012)[96] conducted a review that emphasis on the various fundamental aspects of photodynamic therapy and the research done till date in treating various oral lesions using this new therapeutic approach. The authors stated that applications of PDT in dentistry are growing rapidly in treatment of oral premalignant and malignant conditions and oral microbial diseases, and the photodynamic diagnosis of malignant transformation of oral lesions. The absence of genotoxic and mutogenic effects of PDT is an important factor for long- term safety during treatment. PDT also represents a novel therapeutic approach in the management of oral biofilms.

Shivakumar et al (2012)[88] conducted a review of literature on scope of photodynamic therapy in Periodontics. In his journal he concluded that PDT produced beneficial results and development of new photosensitizes and Light source, needs more research approaches to overcome all the difficulties and challenges of PDT.

Young-Ho Lee et al (2012)[111] evaluated the effect of photodynamic therapy (PDT), using erythrosine as a photosensitizing agent and a dental halogen curing unit as a light source, on Streptococcus *mutans* in a biofilm phase. The result of this study showed significant increase in cell death in the

PDT group. The author concluded that PDT was effective in producing cell death, but had limited effect on biofilms that forms in the presence of sucrose.

Hare Gursoy et al (2012)[41] summarized the recent developments regarding photodynamic therapy (PDT) in the field of dentistry. The authors concluded that PDT seems to be an effective tool in the treatment of localized and superficial infections. It may be used as an adjunctive tool for facilitating the treatment of oral infections.

Isabelle Cappuyns et al (2012)[45] compared the effects of antimicrobial photodynamic therapy (PDT), diode soft laser therapy (DSL), and thorough deep scaling and root planing (SRP) for treatment of residual pockets. The result of this study shows a significant clinical improvement. PDT and SRP suppressed *Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola* stronger, and resulted in fewer persisting pockets after 6 months, than DSL application

Bassir SH et al (2012)[11] evaluated the effectiveness of photo activated disinfection (PAD) using light-emitting diode (LED) as an adjunct to in the management of patients affected by moderate to severe chronic Periodontitis. The authors concluded that the application of PAD using LED had additional benefits on clinical parameters in patients diagnosed with moderate to severe chronic periodontitis compared with SRP alone.

Theodoro et al (2012)[99] conducted a trial to assess the long term clinical and microbiological effects of PDT in conjunction with non-surgical periodontal therapy for treatment of chronic Periodontitis. The result of this

study showed that PDT decreased some key pathogens but had no significant effect on clinical parameters.

Dilsiz et al (2013)[28] designed a randomized controlled clinical trial to compare the clinical effects of Potassium–Titanyl–Phosphate Laser (KTP) and photodynamic therapy (PDT) on the outcomes of treatment of chronic Periodontitis. The Results of the study showed that all treatments yielded significant improvements in terms of Bleeding on probing, Probing pocket depth decrease and Clinical attachment level gain compared to baseline values but a greater reduction in Probing pocket depth and gain in Clinical attachment level in KTP laser group compared to the other groups. The Authors concluded that in patients with chronic periodontitis, clinical outcomes of conventional periodontal treatment of deeper pockets can be improved by using adjunctive KTP laser and single application of photodynamic therapy was not effective as an adjunct to traditional Scaling and Root planing.

Balata et al (2013)[10] conducted a randomized controlled clinical trial to evaluate the effects of photodynamic therapy (PDT) as an adjunct to full-mouth ultrasonic debridement in the treatment of severe chronic periodontitis. The results showed an improvement in Bleeding on probing, Probing pocket depth and Clinical attachment level after treatment, in both groups, but without any difference between them and implied that the PDT did not provide any additional benefit to those obtained with full-mouth ultrasonic debridement alone.

Dorothee Scha et al (2013)[86] compared the adjunctive clinical effects in the non-surgical treatment of peri-implantitis with either local drug delivery

(LDD) or photodynamic therapy (PDT). The authors concluded that in initial peri-implantitis, non-surgical mechanical debridement with adjunctive use of PDT is equally effective in the reduction of mucosal inflammation as with the adjunctive use of minocycline microspheres up to 6 months. Adjunctive PDT may represent an alternative treatment modality in the non-surgical management of initial peri-implantitis.

Luchesi et al (2013)[54] investigated the clinical, microbiological and immunological effects of photodynamic therapy (PDT) as an adjunct to scaling and root planing (SRP) in class II furcation sites in a double-blinded, parallel, randomized controlled clinical trial. The results showed that clinical parameters improved after both therapies with no differences between the groups at any time point while RT-PCR showed a decrease in Porphyromonas *gingivalis and* Tannerella *forsythia* only in the PDT group at 6 months. Regarding cytokines, IL-4 and IL-10 levels increased in both groups at 6 months and GM-CSF, IL-8, IL-1b and IL-6 levels decreased only in the PDT group after 3 months. They concluded that PDT did not promote clinical benefits for class II furcations, however advantages in local levels of cytokines and a reduction in periodontopathogens were demonstrated.

Ewa Mielczarek-Badora et al (2013)[31] in their review to evaluate the effectiveness of aPDT in periodontitis treatment concluded that although aPDT was not superior compared to conventional periodontitis treatment, antimicrobial photodynamic treatment has been reported to be effective as an adjunct to conventional therapy to destroy bacteria in sites where there is limited access for mechanical instrumentation.

Queirozac et al (2013)[77] conducted the clinical study to assess the efficacy of PDT as an adjunct to SRP in smokers with chronic Periodontitis. The result of this study showed that PDT had no superior clinical efficacy to SRP but decreased inflammatory markers like IL-1β, MMP 8.

Petra Rugani et al (2013)[70] reported a case series where patients with Bisphosphonate-related Osteonecrosis of the Jaws (BRONJ) were treated with application of low-level-laser therapy (LLLT) as part of conservative protocols or as adjuvant measure in surgical regimes. The result of this study shows photodynamic therapy help to manage symptoms or may even promote mucosal healing and additionally provides antimicrobial effects and can therefore be used if complications in postoperative healing occur.

Betsy et al (2014)[13] conducted a single-centered randomized controlled clinical trial to evaluate whether adjunctive use of aPDT to SRP has any short-term effectiveness in the management of patients with chronic periodontitis in terms of clinical parameters and halitosis. The results showed statistically significant reduction in Probing Depth and Clincal Attatchment Level in the test group on evaluation at 3 months and 6 months and a significant difference was detected for the test group at 1 month in terms of halitosis as compared to the control group. The results imply that aPDT has an important role to play in improving clinical outcomes obtained through SRP and it would be worthwhile to repeat aPDT at frequent intervals to obtain a more definitive cure.

Kolbe et al (2014)[49] designed a split-mouth study, to investigate the clinical, microbiologic, immune inflammatory and patient-centered effects of

PDT as a mono therapy during periodontal maintenance in patients with at least 3 residual pockets. The authors concluded that PDT as an exclusive therapy may be considered a non-invasive alternative for treating residual pockets, offering advantages in the modulation of cytokines.

Garcia et al (2014)[34] assessed the bone loss and the immune inflammatory response of Wistar rats to 2 photosensitizing agents (Methylene Blue and Toluidine Blue O) at 2 different concentrations in antimicrobial photodynamic therapy (aPDT), used as an adjuvant therapy in the treatment of periodontitis. The results showed that there was significantly less bone loss in animals treated with aPDT using low concentrations of MB and TBO at 7, 15 and 30 days. The authors concluded that aPDT, using low concentrations of MB and TBO, was the most effective adjuvant therapy to SRP, acting indirectly as a down regulator of the molecular mechanisms that control bone resorption in periodontitis.

Reza Pourabbas et al (2014)[81] conducted a study to evaluate the effects of photodynamic therapy (PDT) as an adjunct to conventional scaling and root planing (SRP) on clinical and biologic features of periodontitis. The authors concluded that, in patients with Chronic Periodontitis, a single application of PDT using a 638-nm laser and Toluidine blue did not provide any additional benefit to SRP in terms of clinical parameters or inflammatory markers 3 months following the intervention.

Santin, Oliveira et al (2014)[33] conducted a systematic review of the literature on the efficacy of antimicrobial photodynamic therapy (aPDT) on cariogenic dental biofilm. The author concluded that the practical implication

does not allow drawing any concrete conclusions regarding the efficacy of aPDT, although this method seems to be a promising option.

Pour Abbas et al (2014)[81] conducted a split mouth study to compare the clinical parameters and cytokine profile (IL-1β, TNF α, MMP 8, MMP 9) in GCF of moderate to severe periodontitis patients after SRP+PDT and SRP alone. The result of this study showed that PDT had no superior efficacy to SRP after 3 months.

Petelin et al (2014)[69] compared the effects of ultrasonic SRP in conjunction with multistep PDT, ultrasonic SRP alone and manual SRP on sub gingival pathogens in chronic Periodontitis Patients. The result of this study shows the PDT caused a greater reduction in Aggretibacter *actinomycetecomitans*, Tannerella *forsythia* and Treneopema *denticola* compared to mechanical debridement alone.

Queiroz et al (2014)[73] conducted a clinical trial to assess of the microbiological effects of PDT as an adjunct to non-surgical periodontal therapy in smokers with chronic Periodontitis. The result of this study shows that neither PDT and SRP nor SRP alone decreased the microbial count in smokers.

Carvalho et al (2015)[20] evaluated the clinical and microbiological effects of PDT in the treatment of residual pockets in patients with chronic periodontitis subjected to supportive therapy. The result of this study showed that all treatments resulted in significant clinical improvement in patients with residual periodontal pockets but did not find any additional significant benefit of PDT in terms of PPD, CAL, BOP and pathogens levels reduction and

concluded that the PDT protocol used in this study is not superior to supra gingival plaque control in persistent pockets.

Mohammadreza Talebi et al (2015)[62] reviewed the applications and efficacy of PDT for treatment of chronic and aggressive periodontitis. They concluded that, PDT is a minimally invasive treatment for periodontal disease. Methodological limitations of studies in this regard prevent a conclusion being drawn regarding the optimal efficacy of PDT as an adjunct for treatment of periodontitis.

Marco Giannelli et al (2015)[57] conducted a study to evaluate the effectiveness of combined Photoablative-Photodynamic (PAPD) Diode Laser Therapy as a adjunctive to Scaling and Root Planing in treatment of Periodontitis. The results of this 4-year follow-up study showed that PAPD plus SRP provided significant, durable improvement in chronic Periodontitis Patients.

Chetan Raut et al (2015)[21] evaluated the clinical effects of the adjunctive use of PDT to scaling and root planing in chronic periodontitis patients. The authors concluded that the additional application of a single episode of PDT to scaling and root planing resulted in an additional improvement in terms of Pocket depth reduction and Clinical attachment level gain, but it resulted in a significantly higher reduction in bleeding scores compared to scaling and root planing alone.

Al Habashneh et al (2015)[3] conducted a review to provide an overview of the current status and use of PDT. Based on the results, there is promising,preliminary, information regarding the benefits of PDT use on periodontal treatment outcomes. The authors concluded that the use of PDT

may help improve periodontal outcomes. Therefore, it could become a new method for antibacterial treatment and may be used as an adjunct to or as conventional therapy for the treatment of periodontal and peri-implant diseases.

Vohra R et al (2015)[103] conducted a systematic review to assess the efficacy of antimicrobial photodynamic therapy in the treatment of aggressive periodontitis. The result showed significant improvement in periodontal parameters for subjects receiving aPDT as an adjunct to SRP as compared to treatment with SRP alone at follow up. The authors concluded the evidence supports aPDT as an effective adjunct to SRP in treatment of Aggressive periodontitis. However, more RCTs with specific control groups, standardized protocols, and comparisons with localized application of antibiotics are needed to interpret the efficacy of aPDT + SRP in patients with Aggressive periodontitis.

Alwaeli et al (2015)[6] assessed the long term clinical efficacy of PDT associated with SRP in treatment of chronic Periodontitis. The authors suggested PDT, as an adjunct to be a novel approach for the treatment of Periodontitis.

Georgios-Sokratis et al (2015)[36] investigated the possible role of PDT in the treatment of Aggressive Periodontitis as an adjunctive therapy or mono therapy and concluded that PDT may exhibit a beneficial role in the therapy of aggressive periodontitis after repeated applications. In the future direction, more methodologically sound, long-term randomized clinical trials are needed to be conducted.

Vivek Kumar et al (2015)[53] concluded that PDT as a low-level therapy with short irradiation time does not produce any thermal change within the gingival tissue and root surface or destruction of the intact attachment apparatus at the base of pockets. PDT may be effective and could provide a better option than antibiotics or other mechanical methods for treating periodontal diseases and may prove to be a promising alternative to conventional periodontal therapy in near future.

Soria-Lozano et al (2015)[94] compared the photo inactivation effect of three photo sensitizers, Methylene Blue, Rose Bengal and Curcurmin, on *S. mutans*, *S. sanguis* and *C. albicans*. The authors concluded that Photodynamic therapy with Rose Bengal, Methylene Blue and Curcurmin and white light is effective in killing S. *mutans* and S. *sanguis* strains, although MB and RB are more efficient than CUR. Candida. *albicans* required higher concentrations of all photo sensitizers to obtain a fungicidal effect, being MB the most efficient and CUR ineffective.

Ramos et al (2016)[80] conducted a double-blinded, placebo-controlled clinical study to compare, clinically and immunologically, a protocol of multiple antimicrobial photodynamic therapy (aPDT) applications and the use of systemic doxycycline as adjuvant to SRP on the treatment of uncontrolled type 2 diabetic patients. The results showed no significant difference in HbA1c, between treatments and the SRP + aPDT group showed advantage on reducing moderate pockets in single- rooted teeth and IL-1β levels at 3 months. There were no significant differences between TNF-α and TGF-β. They concluded that both treatments were able to improve the periodontal treatment outcomes in uncontrolled type 2 diabetic patients and adjunctive use

of aPDT apparently presents advantages towards systemic doxycycline when dealing with moderate PPD in single- rooted teeth.

Singh S et al (2016)[91] in his article discussed the use of bio photonics for the diagnosis and therapy of Periodontics. He has stated that PDT will be useful in periodontal bone loss, management of furcations, implantology, periodontal wound healing and also management of Periodontitis.

Meimandi M et al (2017)[58] in their review about the effect of photodynamic therapy in the treatment of chronic periodontitis concluded that considering the safety, the lack of side effects and general advantages like more patient compliance, the PDT treatment with scaling and root planing (SRP) is recommended as an efficient adjunctive modality for the treatment of localized chronic periodontitis especially during the maintenance phase in non-surgical treatment.

Thomas George V et al (2017)[100] conducted a review that provides an overview of PDT in the management of periodontal disease, and concluded that, the available knowledge of PDT should encourage a more clinically oriented application of this technique.

Alparslan Dilsiz et al (2017)[5] in a systematic review about Photodynamic therapy in the treatment of periodontal disease stated that, some current studies showed that a number of the periodontal pathogens are susceptible to low level laser in the presence of Photosensitizer, suggesting that PDT is advantageous for conventional periodontal therapy. Whereas others reported that adjunctive use of PDT showed no significant benefits. Further studies are required to explore its extensive novel clinical applications.

Juliana Marotti et al (2017)[48] described a case of severe peri-implantitis in the anterior region of the maxilla successfully managed with the association of photodynamic therapy and conventional surgical treatment. The result of this study showed that one year after the treatment, no bleeding on probing was observed and peri-implant pocket depths were reduced to 1 mm to 3 mm. the authors concluded that the treatment protocol, combined with photodynamic treatment, allowed the reduction of pathogenic bacteria and promoted the health of peri-implant tissues for a period of up to 5 years of follow-up.

Suchetha A et al (2017)[95] conducted a study to compare the efficacy of PDT with scaling and root planing (SRP) and also to compare the efficacy of two different concentrations of Photosensitizer (methylene blue 0.005% and 0.01%) in the treatment of chronic periodontitis. The Results of this study showed that at 1 and 3 months after treatment, there were no statistically significant differences between the groups with regard to reduction in Plaque index, Gingival index, and probing pocket depth in all groups. The authors concluded that additional application of a single episode of PDT to SRP failed to result in an additional improvement in terms of reduction in plaque score, gingival index score, and pocket probing depth.

Takahiro Hokari et al (2018)[97] conducted a study to compare the efficacies of antimicrobial photodynamic therapy (aPDT) and minocycline ointment (MO) on clinical and bacteriological markers and the local host inflammatory response. The authors concluded the that Local MO administration exhibited a significant decrease in scores for clinical parameters and a significant reduction in bacterial counts and interleukin-1β

and interferon-γ levels at 1 and 4 weeks after treatment. No significant changes were observed in the aPDT group, except in clinical parameters. The authors had some limitations, found that while local administration of MO may slightly help to improve clinical, microbiological, and crevicular cytokine levels in periodontal pockets, aPDT did not show any effects.

MATERIALS AND METHODS

MATERIALS AND METHODS

The study was conducted in the outpatient department of periodontology, CSI College of Dental Sciences and Research, Madurai, Tamilnadu. Thirty two patients (20 males and 12 females) aged between 30-65 years and diagnosed as chronic periodontitis were selected for the study.

Institutional Ethical committee approval (IEC NO.0020/2016 dated 8.9.2016) and written informed consent from all participants were obtained prior to initiation of the study.

A split mouth design was used, so that each patient acted as their own control. One quadrant on each side was randomized to the two treatment arms.

Control site	**Scaling and Root planing alone (SRP)**
Experimental site	**Scaling and Root planing along with Photodynamic therapy (SRP + PDT)**

Inclusion criteria:

1. Patient had at least 20 teeth, with a minimum of 4 multi rooted teeth and 4 teeth per quadrant.
2. All the patients were diagnosed as chronic Periodontitis patients.
3. 15% of the sites had pocket depth ≥ 5 mm and bleeding on probing was present.
4. Radiographic evidence of bone loss was present.

Exclusion Criteria:

1. Patient with habit of smoking and alcohol consumption.
2. Patient who have taken antibiotics within 6 months prior or during the trial.
3. Patient suffering from systemic diseases and/or taking medication likely to induce gingival hypertrophy.
4. Patient with cervical abrasion, extensive carious lesion, fractured teeth.
5. Patient under orthodontic therapy or wearing removal denture.
6. Patients allergic to any drugs or chemicals.

STUDY DESIGN

Treatment protocol:

All patients received standard periodontal therapy, Scaling and root planing using an ultrasonic scaler and standard periodontal curettes. Oral hygiene instruction was given. In the experimental site, all the pockets with probing pocket depth ≥ 5 mm were additionally treated with photodynamic therapy immediately after mechanical debridement.

Preparation of the Photosensitizer (1% Methylene blue)

1 gm of Methylene blue powder was added to 100 ml of distilled water in a borosil beaker and stirred until the powder dissolved completely. The mixture was filtered twice through whatman filter paper to remove any particles or remnants. The solution was transferred to an amber bottle and stored for application.

Preparation of light source

The Laser unit device used was Picasso diode laser operating at 810 nm with an output power of 1W to 5W, with a fibre optic tip. The unit was set at continuous mode. Protective eye wear was used for the patient, the operator and the assistant.

Application of Photosensitizer

The freshly prepared dye was applied with a blunt needle inserted subgingivally and placed in contact with bottom of the pocket. The dye was slowly released while the needle was gently moved in the coronal direction. The pockets were deliberately overfilled. The excess dye was removed 2 minutes following its application, by gentle irrigation with 10 % normal saline solution.

Photodynamic Therapy

The fiber optic tip was inserted subgingivally and the site was irradiated with the tip continuously moving in the mesio distal direction on both the buccal and lingual sides. Each selected teeth was irradiated for 60 seconds. The surrounding tissues were adequately cooled with wet gauze, placed around irradiated the tooth.

Examination Criteria

The following periodontal parameters were recorded in a sequential order at baseline, 1 month, 3 month, and 6 month after therapy.

CLINICAL PARAMETERS[93]

a. Plaque index (PI)
b. Gingival index (GI)
c. Papillary Bleeding index (PBI)
d. Probing Pocket Depth (PPD)
e. Location of the gingival margin from the CEJ / Gingival Recession (GR)
f. Clinical Attachment Level (CAL)

Plaque Index (PI) Quigley and Hein Plaque Index – 1962

Was measured in all teeth. The scores ranged from 0 – 5

SCORE	CRITERIA
0	No Plaque
1	Separate flecks of plaque at cervical margin of the tooth
2	A thin continuous band of plaque at the cervical margin.
3	A band of plaque wider than 1 mm but covering less than 1/3 of the crown of the tooth.
4	Plaque covering at least 1/3 but less than 2/3 of the crown
5	Plaque covering 2/3 or more of the crown

Gingival Index (GI) (Loe H and Silness J-1963)

Was measured in all teeth. The scores ranged from 0 - 3

SCORE	CRITERIA
0	Normal Gingiva
1	Mild Inflammation, Slight change in color, Slight edema, no bleeding on probing.
2	Moderate Inflammation, redness, edema, glazing, bleeding on probing.
3	Severe Inflammation, marked redness and edema, ulceration, tendency to spontaneous bleeding.

Papillary Bleeding Index (PBI) (H.R. Muhlemann and S.Son. 1977)

Was measured in all teeth. The scores ranged from 0 – 4

SCORE	CRITERIA
0	No Bleeding
1	A single discreet bleeding points appears
2	Several isolated bleeding points or a single line of blood appears
3	The inter dental triangle fills with blood shortly after probing
4	Profuse bleeding occurs after probing, blood flows immediately into the marginal sulcus.

Probing Pocket Depth (PPD)

Probing pocket depth was measured with University of North Carolina Probe (UNC-15) in millimeters (mm). The baseline pocket depth was measured from the free gingival margin to the bottom of the pocket in all teeth immediately after scaling and root planing.

Location of the Gingival margin to the Cementoenamel Junction/ Gingival Recession (GR)

Location of the gingival margin in relation to the cementoenamel junction was measured to the nearest millimeter.

Clinical Attachment Level (CAL)

Was calculated for each site as the sum of the Probing Pocket Depth and the Gingival Recession.

Statistical analysis

The difference between pre operative and follow up measurement of Plaque Index, Gingival Index, Papillary Bleeding Index, Probing Pocket Depth, and Clinical Attachment Level of each patient were computed.

The mean difference between the values at baseline, 1 month, 3 month and 6 month were tested for significance by Paired T-Test. The mean difference between the Experimental and Control sites were tested for significance by two sample independent T-Test.

Armamentarium

1. Disposable gloves and Mask
2. Mouth mirror
3. Explorer
4. University of North Carolina Probe (UNC 15 Probe)
5. Tweezers
6. Stainless Steel Bowl
7. Local Anesthetic Agents – Lignocaine 2%
8. Disposable Syringe with needle (2 ml)
9. Ultrasonic Scalers (Wood Pecker)
10. Gracey Curettes (Hu-Friedy)
11. Freshly prepared Methylene Blue (M 9140;Sigma Aldrich)
12. Normal Saline for Irrigation (NS 10%)
13. Disposable Syringe (10 ml) and Disposable Needle
14. Sterile Gauze
15. Laser Unit (Diode – Picasso)
16. Safety Eye Wear

FIGURE 4: ARMAMENTRIUM FOR CLINICAL PROCEDURE

A. Armamentarium for non surgical therapy

B. Armamentarium for Diode Laser - Picasso

C. Armamentarium of non surgical therapy and

1% Methylene Blue

FIGURE 5: PREPARATION OF METHYLENE BLUE

D. Methylene Blue

E. 1 gm of Methylene Blue

F.100 ml Distilled Water

G. Methylene Blue added to Distilled water

H. Stirred with stirrer

FIGURE 6: PRE OPERATIVE VIEW

I. Front View

J.Right Lateral View

K. Left Lateral View

L. Palatal View

M. Lingual View

N. Probing Pocket Depth

FIGURE 7: Non Surgical Therapy

(SCALING AND ROOT PLANING – I, II, III, IV QUADRANT)

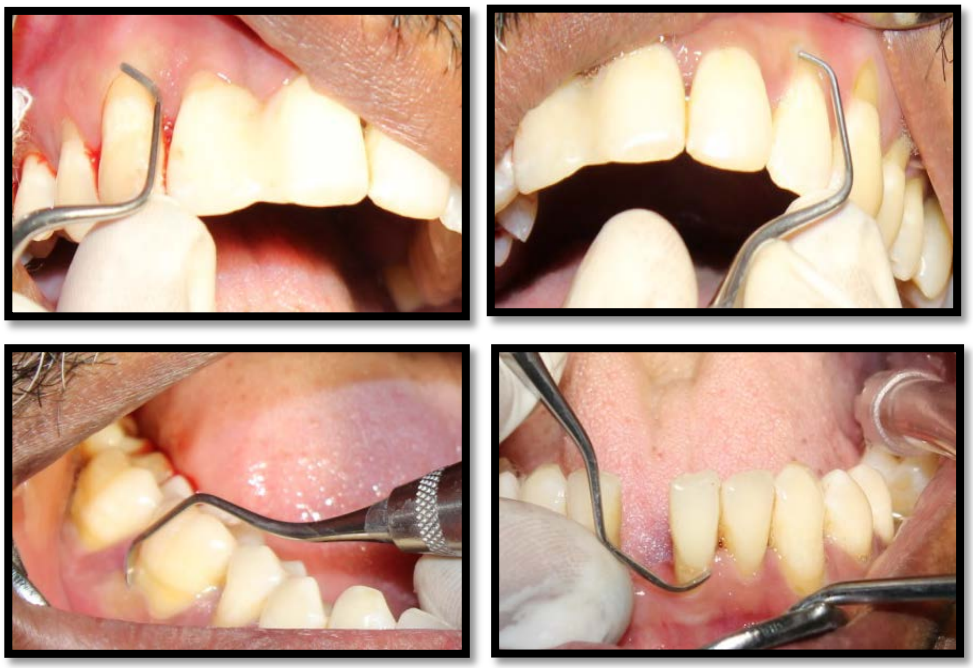


FIGURE 8: APPLICATION OF PHOTOSENSITIZER

II & III QUADRANT

FIGURE 9: IRRADIATION WITH LASER II & III QUADRANT

FIGURE 10: POST OPERATIVE VIEW

IMMEDIATE

1 MONTH

3 MONTH

6 MONTH

POCKET DEPTH

RESULTS

RESULTS

The Clinical trial was performed on 32 patients, aged between 30 to 65 years. (20 Males and 12 Females)

The study design was a split mouth design in which all the patients were treated by scaling and root planing on the control side. The experimental side was additionally treated with Photodynamic therapy.

Clinical Parameters such as Plaque index, Gingival index, Papillary bleeding index, Probing pocket depth, Clinical attachment level were recorded at baseline, 1 month, 3 month and 6 month and were subjected to statistical analysis. The following results were obtained.

Table 1: Mean and Standard Deviation of Pre and Post treatment Plaque Index in Experimental and Control sites

	Experimental (N=32)			Control (N=32)		
	Mean ± SD	**t-value**	**P-value**	**Mean ± SD**	**t-value**	**P-value**
Baseline	2.6 ± 0.31			2.55 ± 0.32		
1 month	0.41 ± 0.32	31.23	<0.01	0.65 ± 0.36	21.13	<0.01
3 month	1.09 ± 0.37	17.41	<0.01	1.35 ±0.42	12.27	<0.01
6 month	1.52 ± 0.45	11.35	<0.01	1.76 ± 0.47	7.795	<0.01

Graph 1: Plaque Index at baseline, 1st month, 3rd month and 6th month between Experimental and Control group

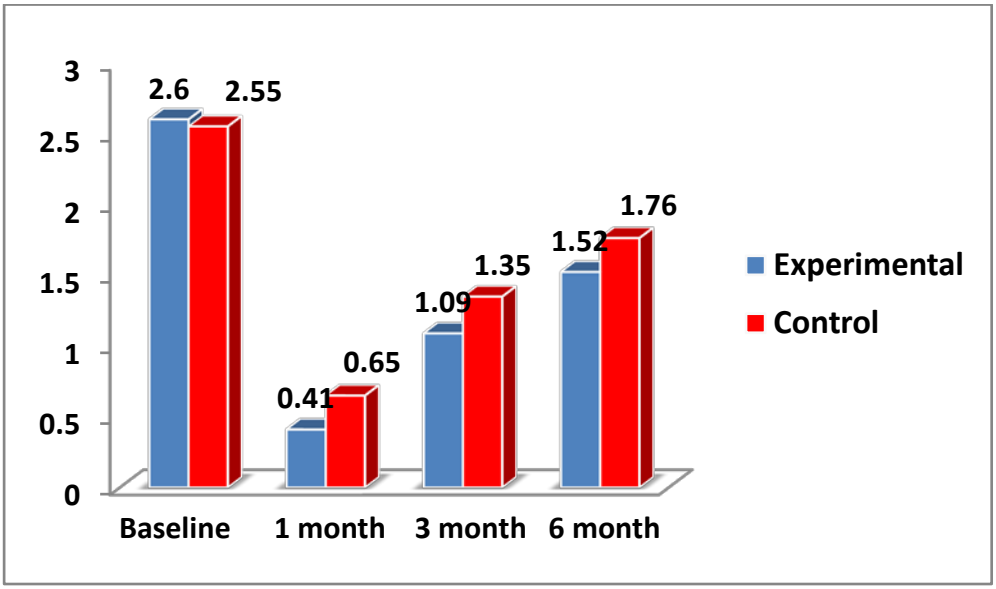


Table 1 and Graph 1 show the mean of Plaque index score at baseline, 1 month, 3 month and 6 month.

The mean Plaque index score at baseline was 2.6 with standard deviation 0.31 in the experimental sites.

Post operative plaque index score was reduced to 0.41 at 1st month, 1.09 at 3rd month and 1.52 at 6th month.

The mean change in plaque index score was 2.19 at 1st month, 1.51 at 3rd month, 1.08 at 6th month which was statistically significant. (P value < 0.01)

The mean Plaque index score at baseline was 2.55 with standard deviation 0.32 in the control sites.

Post operative plaque index score was reduced to 0.65 at 1st month, 1.35 at 3rd month and 1.76 at 6th month.

The mean change in plaque index score was 1.90 at 1st month, 1.20 at 3rd month, 0.79 at 6th month which was statistically significant. (P value < 0.01)

Table 2: Mean and Standard Deviation of Plaque index at 1st month, 3rd month and 6th month, between Experimental and Control sites

Site	1 month			3 month			6 month		
	Mean ± SD	**t-value**	**P value**	**Mean ± SD**	**t-value**	**P value**	**Mean ± SD**	**t-value**	**P value**
Experimental	0.41 ±0.32	2.84	<0.01	1.09 ±0.37	2.06	<0.01	1.52 ±0.45	2.12	<0.01
Control	0.65 ±0.36			1.35 ±0.42			1.76 ±0.47		

Table 2 show the mean of Plaque index score between the experimental and control sites.

Paired t-test was applied to compare the mean and standard deviation of plaque index score at 1st month, 3rd month, and 6th months between experimental and control sites.

At 1st month there was mean difference of 0.24 between the experimental and control sites that was statistically significant. (P-value < 0.01)

At 3rd month there was mean difference of 0.26 between the experimental and control site that was statistically significant (P value < 0.01)

At 6th month there was mean difference of 0.24 between the experimental and control site that was statistically significant. (P value < 0.01)

Photodynamic therapy, when used along with scaling and root planing caused more reduction in plaque index score when compared to scaling and root planing.

Table 3: Mean and Standard Deviation of Pre and Post treatment Gingival Index in Experimental and Control sites

	Experimental (N=32)			Control (N=32)		
	Mean ± SD	t-value	P-value	Mean ± SD	t-value	P-value
Baseline	2.66 ± 0.41			2.71 ± 0.39		
1 month	0.54 ± 0.39	18.24	<0.01	0.82 ± 0.41	17.76	<0.01
3 month	1.09 ± 0.34	14.41	<0.01	1.43 ± 0.43	11.54	<0.01
6 month	1.58 ± 0.44	9.45	<0.01	1.98 ± 0.56	6.05	<0.01

Graph 2: Gingival index at baseline, 1st month, 3rd month and 6th month between Experimental and Control group

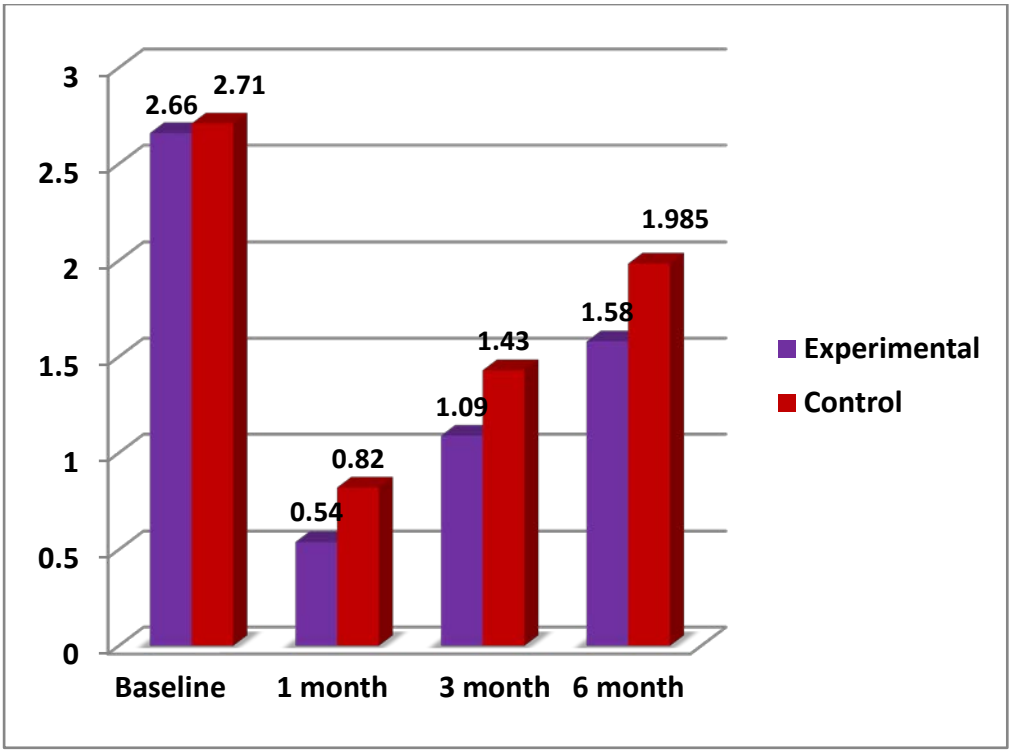


Table 3 and Graph 2 show the mean of Gingival index score at baseline, 1 month, 3 month and 6 month.

The mean gingival index score at baseline was 2.66 with standard deviation 0.41 in the experimental sites.

Post operative gingival index score was reduced to 0.54 at 1st month, 1.09 at 3rd month and 1.58 at 6th month.

The mean change in gingival index score was 2.12 at 1st month, 1.57 at 3rd month, 1.08 at 6th month which was statistically significant. (P- Value < 0.01)

The mean gingival index score at baseline was 2.71 with standard deviation 0.39 in the control sites.

Post operative gingival index score was reduced to 0.82 at 1st month 1.43 at 3rd month and 1.98 at 6th month.

The mean change in gingival index score was 1.89 at 1st month, 1.28 at 3rd month, and 0.73 at 6th month which was statistically significant. (P value < 0.01)

Table 4: Mean and Standard Deviation of Gingival index at 1st month, 3rd month and 6th month, between Experimental and Control sites

Site	1 month			3 month			6 month		
	Mean ± SD	t-value	P value	Mean ± SD	t-value	P value	Mean ± SD	t-value	P value
Experimental	0.54± 0.39	2.76	<0.01	1.09±0.34	3.38	<0.01	1.58 ±0.44	3.15	<0.01
Control	0.82± 0.42			1.43 ±0.44			1.98 ±0.56		

Table 4 shows the mean of Gingival index score between the experimental and control sites.

Paired t-test was applied to compare the mean and standard deviation of gingival index score at 1st month, 3rd month, and 6th month between experimental and control sites.

At 1st month there was mean difference of 0.28 between the experimental and control sites that was statistically significant. (P-value < 0.01)

At 3rd month there was mean difference of 0.34 between the experimental and control site that was statistically significant (P- value < 0.01)

At 6th month there was mean difference of 0.40 between the experimental and control site that was statistically significant. (P- value < 0.01)

Photodynamic therapy, when used along with scaling and root planing caused more reduction in Gingival index score when compared to scaling and root planing.

Table 5: Mean and Standard Deviation of Pre and Post treatment Papillary bleeding index in Experimental and Control sites

	Experimental (N=32)			Control (N=32)		
	Mean ± SD	t-value	P-value	Mean ± SD	t-value	P-value
Baseline	2.92 ±0.33			2.88 ± 0.34		
1 month	0.77±0.611	18.85	<0.01	0.89 ± 0.49	20.18	<0.01
3 month	1.4 ± 0.56	15.53	<0.01	1.66 ± 0.7	9.51	<0.01
6 month	1.9 ± 0.65	9.35	<0.01	2.33 ± 0.82	3.98	<0.01

Graph 3: Papillary Bleeding index at baseline, 1st month, 3rd month and 6th month between Experimental and Control group

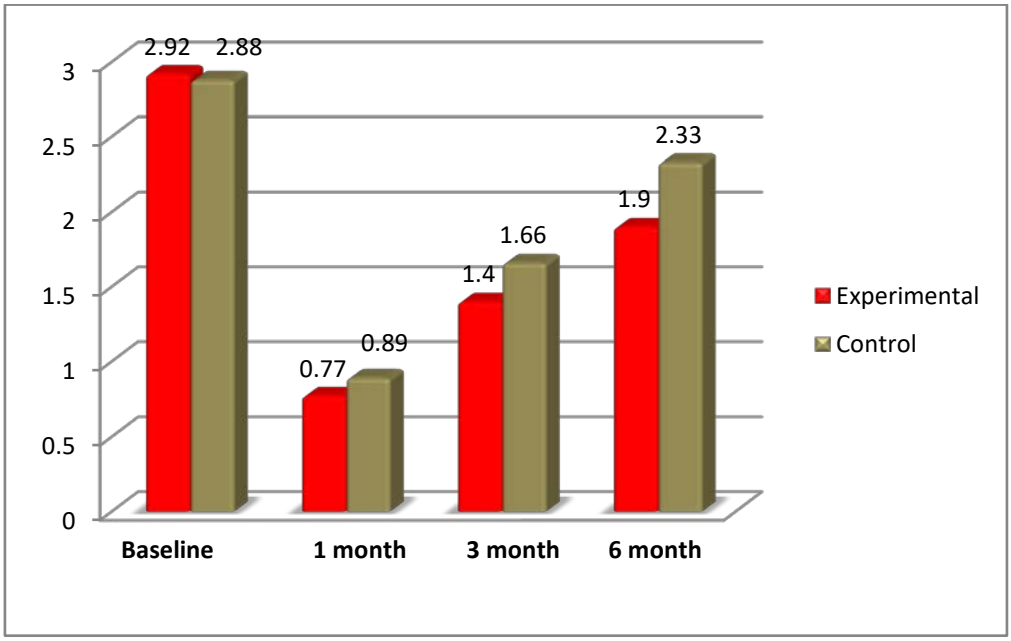


Table 5 and Graph 3 show the mean of Papillary bleeding index score at baseline, 1 month, 3 month and 6 month.

The mean Papillary bleeding index score at baseline was 2.92 with standard deviation 0.33 in the experimental sites.

Postoperative papillary bleeding index score was reduced to 0.77 at 1st month, 1.40 at 3rd month and 1.90 at 6th month.

The mean change in papillary bleeding index score was 2.15 at 1st month, 1.52 at 3rd month, 1.02 at 6th month which was statistically significant. (P- value < 0.01)

The mean Papillary bleeding index score at baseline was 2.88 with standard deviation 0.34 in the control sites.

Post operative papillary index score was reduced to 0.89 at 1st month 1.66 at 3rd month and 2.33 at 6th month.

The mean change in papillary bleeding index score was 1.99 at 1st month, 1.22 at 3rd month, and 0.55 at 6th month which was statistically significant. (P- value < 0.01)

Table 6: Mean and Standard Deviation of Papillary Bleeding index at 1st month, 3rd month and 6th month, between Experimental and Control sites

Site	1 month			3 month			6 month		
	Mean ± SD	t-value	P value	Mean ± SD	t-value	P value	Mean ± SD	t-value	P value
Experimental	0.77± 0.61	0.815	0.0958	1.4 ± 0.56	1.67	0.0932	1.9± 0.65	2.32	<0.05
Control	0.89 ±0.49			1.66 ±0.7			2.33 ±0.82		

Table 6 shows the mean of Papillary bleeding index score between the experimental and control sites.

Paired t-test was applied to compare the mean and standard deviation of papillary bleeding index score at 1st month, 3rd month, and 6th month between experimental and control sites.

At 1st month there was mean difference of 0.12 between the experimental and control sites that was not statistically significant. (P-value > 0.05)

At 3rd month there was mean difference of 0.26 between the experimental and control site that was statistically significant (P- value > 0.05)

At 6th month there was mean difference of 0.43 between the experimental and control site that was statistically significant. (P-value < 0.05)

Photodynamic therapy, when used along with Scaling and Root planing did not cause more reduction in Papillary Bleeding Index when compared to scaling and root planing after 1 month and 3 month. But after 6 months Photodynamic therapy, when used along with Scaling and Root planing caused more reduction in Papillary Bleeding Index when compared to scaling and root planing alone.

Table 7: Mean and Standard Deviation of Pre and Post treatment Probing Pocket Depth in Experimental and Control sites

	Experimental (N=32)			**Control (N=32)**		
	Mean ± SD	**t-value**	**P-value**	**Mean ± SD**	**t-value**	**P-value**
Baseline	5.43 ± 0.51			5.52 ± 0.61		
1 month	3.24 ± 0.28	30.02	<0.01	3.7 ± 0.41	22.19	<0.01
3 month	3.38 ± 0.35	25.38	<0.01	3.84 ± 0.46	21.73	<0.01
6 month	3.5 ± 0.35	23.65	<0.01	4.02 ± 0.47	21.31	<0.01

Graph 4: Probing Pocket Depth at baseline, 1st month, 3rd month and 6th month between Experimental and Control group

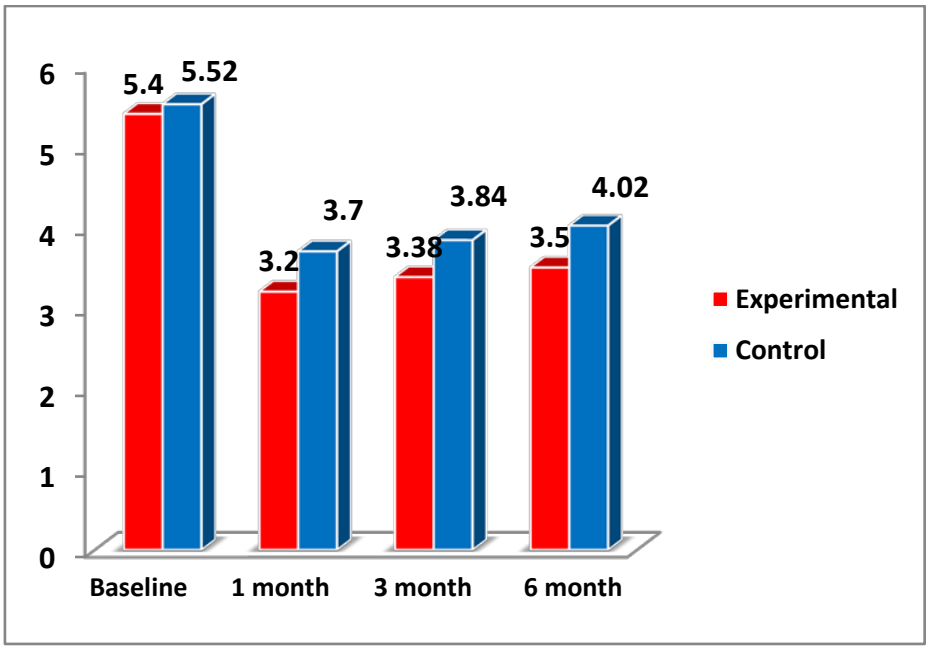


Table 7 and Graph 4 show the mean of Probing Pocket Depth score at baseline, 1 month, 3 month and 6 month.

The mean Probing Pocket Depth score at baseline was 5.43 with standard deviation 0.51 in the experimental sites.

Post operative Probing Pocket Depth score was reduced to 3.24 at 1st month, 3.38 at 3rd month and 3.50 at 6th month.

The mean change in Probing Pocket Depth score was 2.19 at 1st month, 2.05 at 3rd month, 1.93 at 6th month which was statistically significant. (P-value < 0.01)

The mean Probing Pocket Depth score at baseline was 5.52 with standard deviation 0.61 in the control sites.

Postoperative Probing Pocket Depth score was reduced to 3.70 at 1st month 3.84 at 3rd month and 4.02 at 6th month.

The mean change in Probing Pocket Depth score was 1.82 at 1st month, 1.68 at 3rd month, and 1.50 at 6th month which was statistically significant. (P-value < 0.01)

Table 8: Mean and standard deviation of Probing Pocket Depth at 1st month, 3rd month and 6th month, between Experimental and Control sites

Site	1 month			3 month			6 month		
	Mean ± SD	t-value	P value	Mean ± SD	t-value	P value	Mean ± SD	t-value	P value
Experimental	3.2± 0.28	5.21	<0.01	3.38± 0.35	4.46	<0.01	3.5± 0.35	5.5	<0.01
Control	3.7± 0.41			3.84± 0.45			4.02± 0.47		

Table 8 shows the mean of Probing Pocket Depth score between the experimental and control sites.

Paired t-test was applied to compare the mean and standard deviation of Probing Pocket Depth score at 1st month, 3rd month, and 6th month between experimental and control sites.

At 1st month there was mean difference of 0.50 between the experimental and control sites that was statistically significant. (P-value < 0.01)

At 3rd month there was mean difference of 0.46 between the experimental and control site that was statistically significant (P- value < 0.01)

At 6th month there was mean difference of 0.52 between the experimental and control site that was statistically significant. (P- value < 0.01)

Photodynamic therapy, when used along with scaling and root planing caused more reduction in Probing Pocket Depth when compared to scaling and root planing.

Table 9: Mean and Standard Deviation of Pre and Post treatment Clinical Attachment Level in Experimental and Control sites

	Experimental (N=32)			Control (N=32)		
	Mean ± SD	t-value	P-value	Mean ± SD	t-value	P-value
Baseline	5.77 ± 1.27			5.83 ± 1.38		
1 month	3.92 ± 1.01	14.96	<0.01	4.33 ± 1.11	12.82	<0.01
3 month	4.1 ± 1.03	15.55	<0.01	4.54 ± 1.16	10.49	<0.01
6 month	4.23 ± 1.15	13.29	<0.01	4.79 ± 1.31	9.34	<0.01

Graph 5: Clinical Attachment Level at baseline, 1st month, 3rd month and 6th month between Experimental and Control group

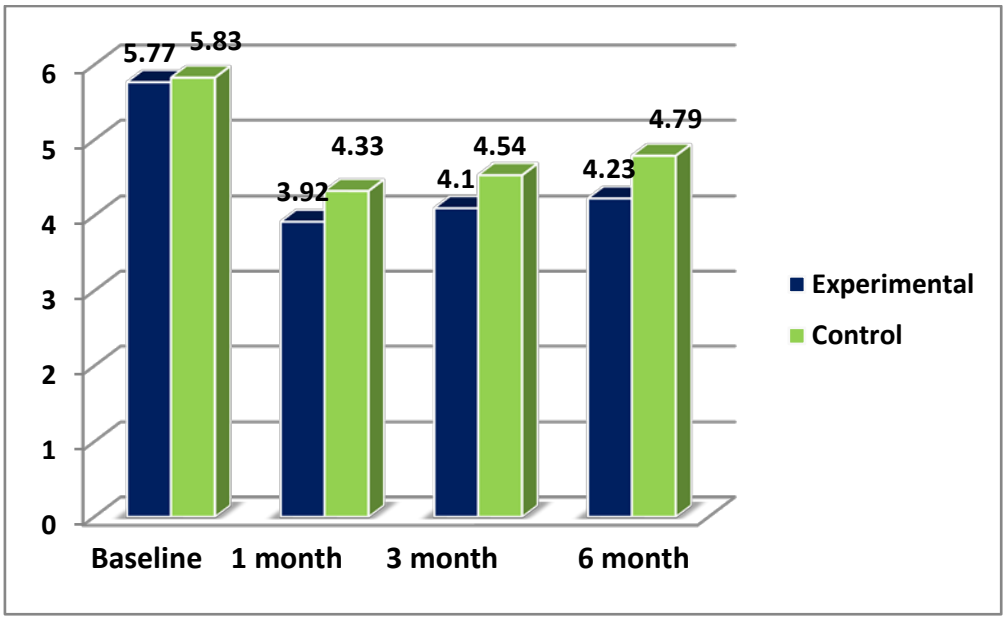


Table 9 and Graph 5 show the mean of Clinical Attachment Level at baseline, 1 month, 3 month and 6 month.

The Mean Clinical Attachment Level at baseline was 5.77 with standard deviation 1.27 in the experimental sites.

Postoperative Clinical Attachment Level was reduced to 3.92 at 1st month, 4.10 at 3rd month and 4.23 at 6th month.

The mean change in Clinical Attachment Level was 1.85 at 1st month, 1.67 at 3rd month, 1.54 at 6th month which was statistically significant. (P-value < 0.01)

The mean Clinical attachment level at baseline was 5.83 with standard deviation 1.38 in the control sites.

Post operative Clinical attachment level score was reduced to 4.33 at 1st month 4.54 at 3rd month and 4.79 at 6th month.

The mean change in Clinical attachment level was 1.50 at 1st month, 1.29 at 3rd month, and 1.04 at 6th month which was statistically significant. (P-value < 0.01)

Table 10: Mean and Standard Deviation of Clinical Attachment Level at 1st month, 3rd month and 6th month, between Experimental and Control sites

Site	1 month			3 month			6 month		
	Mean ± SD	t-value	P value	Mean ± SD	t-value	P value	Mean ± SD	t-value	P value
Experimental	3.92 ±1.01	1.54	>0.05	4.1 ±1.03	1.61	>0.05	4.23 ±1.15	1.79	<0.05
Control	4.33 ±1.18			4.54 ±1.16			4.79 ±1.31		

Table 10 shows the mean of Clinical Attachment Level between the experimental and control sites.

Paired t-test was applied to compare the mean and standard deviation of Clinical Attachment Level score at 1st month, 3rd month, and 6th month between experimental and control sites.

At 1st month there was mean difference of 0.41 between the experimental and control sites that was not statistically significant. (P-value > 0.05)

At 3rd month there was mean difference of 0.44 between the experimental and control site that was not statistically significant (P- value > 0.05))

At 6th month there was mean difference of 0.56 between the experimental and control site that was statistically significant. (P- value < 0.05)

Photodynamic therapy, when used along with Scaling and Root planing did not cause more reduction in Clinical Attachment Level when compared to scaling and root planing after 1 month and 3 month. But after 6 month Photodynamic therapy, when used along with Scaling and Root planing caused more gain in Clinical Attachment Level when compared to scaling and root planing alone.

DISCUSSION

DISCUSSION

Chronic Periodontitis is an infectious disease resulting in inflammation of the supporting tissue of the teeth, progressive attachment loss and bone loss. Plaque biofilms on the tooth and the gingival surface is considered the primary etiology for chronic Periodontitis. (Carranza's Textbook of Clinical Periodontology -11 Edition).[19]

Current concept in the treatment of periodontally involved teeth, are based on conventional treatment approaches such as Scaling and root planing to remove bacterial deposits, calculus, diseased cementum and endotoxins[73, 98]. But this treatment option does not completely eradicate the periodontal pathogens.[1] which are situated deep within the periodontal tissues, dentinal tubules and other inaccessible areas.

In cases not responding to conventional treatment, systemic antibiotics have been used as adjunct to scaling and root planing.[9, 37,101]Although this therapy brings better results, they also had some undesirable effects.[68, 73, 83, and 84]

Bioavailability of the antimicrobial agent at the site of infection was less, thus needed to be administered in larger amount. Also higher concentration of the drug was needed for the drug to be effective against bacteria in biofilms. This increased concentration of the antimicrobial agent produced undesired side effects, as it disrupts the bacterial ecosystem. The most important undesired effect in the use of antibiotics is development of bacterial resistance to the drugs used.[68, 73, and 84]

To overcome these problems many novel approaches have been tried. One such promising approach is the use of antimicrobial Photodynamic therapy.[13, 51]

Photodynamic therapy (PDT) utilizes light to activate a photosensitizing agent (Photosensitizer) in the presence of oxygen. The exposure of the Photosensitizer to light results in the formation of oxygen species, such as singlet oxygen and free radicals, causing localized photo damage and cell death.[51]

Applications of PDT in dentistry are growing rapidly: the treatment of oral cancer, as well as bacterial and fungal infections, and the photodynamic diagnosis (PDD) of the malignant transformation of oral lesions (Sharwani *et al.*, 2006).[87] The non oncological applications of PDT include treatment of psoriasis(Weinstein *et al.*, 1991)[107], actinic keratosis (Itoh *et al.*, 2000)[47],rheumatoid arthritis(Miyazawa *et al.*, 2006)[61], and age-related macular degeneration (Kozak *et al.*, 2006).

Several studies have shown that PDT also has antimicrobial property (Wainwright 1998[105]; Hamblin and Hasan, 2004[40]; Meisel and Kocher, 2005[59]; O'Riordan *et al.*, 2005[66]; Smith,2005; Kömerik and MacRobert, 2006[50]; Wood *et al.*, 2006[108]; Donnelly*et al.*, 2007).[30] Photodynamic antimicrobial chemotherapy (PACT) represents an alternative antibacterial, antifungal, and antiviral treatment for drug-resistant organisms (Wainwright and Crossley,2004).[106] It is unlikely that bacteria would develop resistance to the cytotoxic action of singlet oxygen or free radicals.

Bacteria that grow in biofilms, implicated in diseases like cystic fibrosis (Pseudomonas *aeruginosa*) or periodontitis (Porphyromonas *gingivalis*), are also susceptible to PDT (Bhatti *et al.*, 1998[14]; Wood *et al.*, 1999).[109]

Photodynamic Reaction

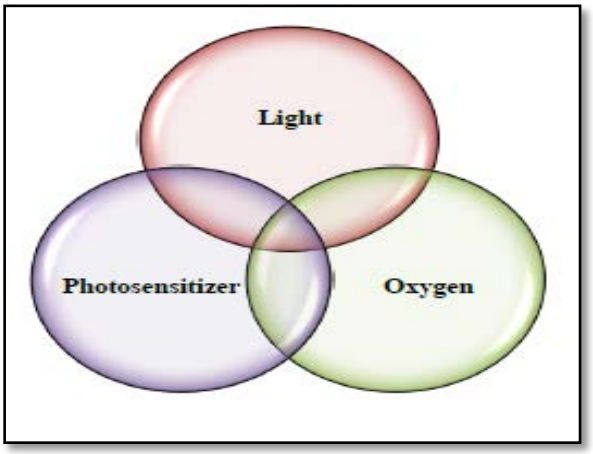


Fig.1 Components of Photodynamic treatment

PDT involves three components: light, a Photosensitizer, and oxygen (Fig 1). A Photosensitizer or its metabolic precursor is administered to the patient. Upon irradiation with light of a specific wave length, the Photosensitizer undergoes a transition from a low-energy ground state to an excited singlet state. Subsequently, the Photosensitizer may decay back to its ground state, with emission of fluorescence, or may undergo a transition to a high energy triplet state. The triplet state can react with endogenous oxygen to produce singlet oxygen and other radical species, causing a rapid and selective destruction of the target tissue. There are two mechanisms by which the triplet-state Photosensitizer can react with biomolecular.[51]

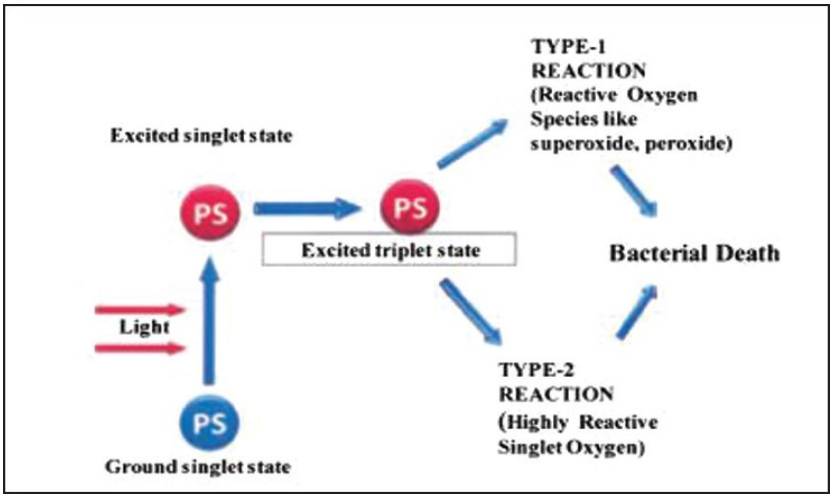


Fig 2 – Mechanism of Action of Photodynamic therapy

Type I involves electron/hydrogen transfer directly from the Photosensitizer, producing ions, or electron/hydrogen removal from a substrate molecule to form free radicals. These radicals react rapidly with oxygen, resulting in the production of highly reactive oxygen species (superoxide, hydroxyl radicals, hydrogen peroxide). [51]

Type II reactions produce the electronically excited and highly reactive state of oxygen known as singlet oxygen. In PDT, it is difficult to distinguish between the two reactions mechanisms. A contribution from both Types I and II processes indicates that the mechanism of damage is dependent on both oxygen tension and Photosensitizer concentration.[51]

PHOTODYNAMIC ANTIMICROBIAL CHEMOTHERAPY (PACT)

It has been known since the beginning of the last century that micro-organisms can be killed by the combination of dyes and light. In recent years, the emergence of antibiotic resistant strains, such as methicillin resistant Staphylococcus *aureus* and vancomycin-resistant Enterococcus *faecalis,* stimulated a search for alternative treatments. PACT has the potential to be such an alternative, especially for the treatment of localized infections of the

skin and the oral cavity. PACT is preferred using the oral cavity because of easy assesibiltity to eradication.[50, 51, 111, 112]

Bacterial resistance to PACT appears to be unlikely, since, in microbial cells, singlet oxygen and free radicals interact with several cell structures and different metabolic pathways. PACT is equally effective against antibiotic-resistant and antibiotic-susceptible bacteria, and repeated photosensitization has not induced the selection of resistant strains (Wainwright and Crossley, 2004)[106]. Antioxidant enzymes, such as superoxide dismutase and catalase, protect against some oxygen radicals, but not against singlet oxygen.[51]

The Photosensitizer can be delivered to infected areas by topical application, instillation, interstitial injection, or aerosol delivery. Several publications have summarized the photobiology of PACT, and its potential for the treatment of localized infections (Hamblin and Hasan, 2004[40]; Wainwright and Crossley, 2004[106]; O'Riordan *et al.*, 2005[66]; Meisel and Kocher, 2005[59]; Smith, 2005; Kömerik and MacRobert, 2006).[50]

A few studies have evaluated the use of PACT in animal models or in clinical trials, mainly for viral lesions, acne, gastric infection by Helicobacter *pylori*, and brain abscesses (reviewed by Hamblin and Hasan, 2004[40]; O'Riordan *et al.*, 2005).[66] The *in vitro* effect of PACT has been investigated primarily against micro-organisms growing in liquid (planktonic) cultures.

Effects of PACT on Oral Biofilms

The antimicrobial activity of photosensitizer is mediated by singlet oxygen, which, because of its high chemical reactivity, has a direct effect on extracellular molecules. Thus, the polysaccharides present in EMP of a bacterial biofilm are also susceptible to photo damage. Such dual activity, not

exhibited by antibiotics, represents a significant advantage of PACT[112]. Breaking down biofilms may inhibit plasmid exchange involved in the transfer of antibiotic resistance, and disrupt colonization. PACT was increasingly more effective as the biofilm age increased, suggesting that "young" biofilms are less susceptible than "older" biofilms (Wood *et al.*, 2006).[108] In contrast, Zanin *et al.* (2005)[112], using TBO as a Photosensitizer, reported that younger biofilms of S. *mutans* are more sensitive to PACT.[51]

In addition to treatment for periodontitis, the use of PACT for peri-implantitis[86, 98] and endodontic treatment has also come into focus. Electron microscopy revealed complete eradication of bacteria in uniform biofilms of Aggregatibacter *actinomycetemcomitans*, Porphyromonas *gingivalis*, or Prevotella *intermedia*, prepared on different implant surfaces treated with TBO and irradiated with a diode soft laser (905 nm) (Haas *et al.*, 1997).[39]

Antimicrobial effect of PDT against periodontal pathogens has been assessed in various in vitro studies, animal studies and in vivo studies by Pfitzner et al (2004)[16], Hayek et al (2005)[23], Qin et al (2008)[24], Christodoulides et al (2008)[32], Fontana et al (2009)[42], Braham et al (2009)[63], Sigusch et al (2010)[65], Nagahara et al (2013)[75], Chui et al (2013)[89], Moreira et al (2015) and Decker et al (2016)[109] with different photosensitizers, wavelengths of light and resident times and have proven to be successful.

Photosensitizer

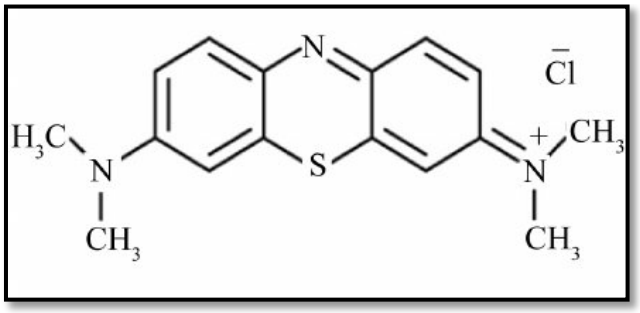
Photosensitizer used in PACT include: (i) phenothiazine dyes Methylene Blue (MB) and Toluidine Blue O (TBO; tolonium chloride)]; (ii) phthalocyanines [aluminum disulphonated phthalocyanine and cationic Zn(II)-phthalocyanine]; (iii) chlorines [chlorin e6, Sn(IV)chlorin e6, chlorin e6-2.5

Nmethyl- d-glucamine (BLC1010)], and polylysine and polyethyleneimine conjugates of chlorine e6; (iv) porphyrins (hematoporphyrin HCl, Photofrin®, and ALA); (v) xanthenes (erythrosin); and (vi) monoterpene (azulene) (Wainwright, 1998). The photosensitivity of bacteria appears to be related to the charge of the sensitizer.[105]

Dobson and Wilson (1992)[29] reported that PDT using Methylene Blue as a Photosentizers was effective against Porphyromonas *gingivalis* a main causative organisms for Chronic Periodontitis using the Methylene Blue Photosensitizer. Similarly Hass et al (1997)[39] reported that Porphyromonas *gingivalis* was killed using the Toluidine Blue as Photosensitizer.

In this study 1% Methylene Blue used as Photosensitizer.

Fig.3- Structure of Methylene Blue



Light Source

PDT requires a source of light to activate the Photosensitizer. Most photo sensitizers are activated by red light between 630 nm and 700 nm (Salva 2002, Kubler 2005).[85]

The total light dose, the dose rates and depth of destruction vary with each sensitizers.(Grant et al 1997,Biel ,Allison et al 2005,2006).[4,15,38]

In past Photosentizers activation was achieved via various light sources such as potassium titanyl phosphate (KTP) Neodymium; yttrium aluminum garnet Nd: YAG laser, diode laser and gold vapor or copper vapour lasers.

In this study, diode lasers system used that are easy to handle, portable and cost effective. (Kulber 2005).

Various randomized control trail results were published by various groups to understand the efficacy of PDT in the treatment of Chronic Periodontitis as an adjunct to Scaling and Root Planing. Studies by Andersen et al 2007[6], Brawn et al 2008[10], Betsy et al 2014[12], Christodoulides et al 2008[13], Berakdar et al 2012[23], Balata et al 2013[27],Alwaeli et al 2013[49] focused on changes in clinical parameters in chronic Periodontitis patients.

Studies by Pour Abbas et al,2014,Quirozac et al 2013,Ge et al 2008 focused on levels of different inflammatory cytokines and inflammatory biomarkers,(GCF had been more commonly evaluated than RANKL,TNFα,IL-1B,MMP8 and MMP 9).[35,77,81]

Queiroz et al 2014,Polansky et al 2009,Christodoulid et al 2008, Petelin et al 2014, Luchesi et al 2013,Cappuyns et al 2012, Meteaux et al 2011, Sigusch et al 2010 focused on microbial changes in Chronic Periodontitis patients treated with PDT.[18,23,54,60,69,72,76,89]

Queiroz et al 2014, Quirozac et al 2013, and Alzahrani et al 2011 investigated the effects of PDT on smokers with chronic Periodontitis.[7, 76, 77]

Yilmaz et al 2002, Polansky et al 2009, Ruhling et al 2009 investigated the effect of PDT on Chronic Periodontitis and concluded that no additional microbiological and clinical benefits over conventional mechanical debridement.[72]

Al-Zaharani et al 2009 in his studies showed No added benefit of PDT on clinical parameters and glycemic control. Pour Abbas et al 2014, Balata et al 2014, Quiozac et al 2013, Luchesi et al 2013, and Theodoro et al 2012 showed that PDT had no superior efficacy to SRP after 6 months.[7, 10,54,77,99]

Although there are numerous studies to evaluate the antimicrobial Photo Dynamic Therapy in the management of Chronic Periodontitis, to the best our knowledge there is only one study done in south Indian population. So this study was conducted to evaluate the effect of Photo Dynamic Therapy in Chronic Periodontitis in South Indian Population.

The results of this study implied that both treatment modalities lead to statistically significant improvements in clinical parameters like plaque index, gingival index and probing pocket depth at 1, 3 and 6 months following therapy. The positive clinical outcomes obtained in the SRP group are in agreement with the previously reported findings of Braun et al 2008, Alwalei et al 2013, Badersten et al 1987 and Weijden et al 2002.[7, 17]

In this study regarding Papillary Bleeding Index and Clinical attachment level though both the interventions yielded a positive outcome at

1month and 3 months, there was no difference between the two treatment modalities. But end of the 6 months the experimental site yielded more improvement in papillary bleeding index and CAL gain compared to control site. These results were in accordance to studies by, Pour Abbas et al 2014, Queiroz et al 2014, Balata et al 2013.[10, 81]

These differences in the results may be due to difference in the treatment modalities, like using photosensitizes at different concentrations, difference in the time of Photosensitizer in the sulcus, difference in light source used, difference in the wavelength of the laser used, difference in irradiation time and also the skill of the clinician. Because of these differences it is impossible to make direct comparison with the previous studies.[85, 105,108]

The obvious limitation of this randomized controlled split mouth clinical trial is the evaluation of clinical parameters alone. Qualitative and Quantitative Microbiological analysis could assess changes in periodontal pathogens.

Another limitation of this clinical trial was the use of a periodontal probe that was not calibrated to standardize probing forces.

In this study only single episode of PDT was performed. Luetic et al 2009[56] suggested that repeated application of Photodynamic Therapy in Chronic Periodontitis led to significantly improved outcomes in all parameters at 6 months. Results of our study also showed that all the clinical parameters at 6 months were nearly equal to the baseline values, so repeated application of PDT every 6 months, may be useful in controlling periodontal destruction in patients with chronic Periodontitis.

Further clinical trials with standardized PDT protocol, large sample size and standardized clinical, biochemical and microbiological assessment must be undertaken, to determine the efficacy of adjunctive effect of PDT with SRP, and to establish the number of PDT applications and the interval between them that offer the best results over time.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The present study has been undertaken to evaluate the efficacy of photodynamic therapy as an adjunct to Scaling and Root Planing in the management of chronic periodontitis patients. 32 patients in the age group of 30 to 65 years, who were diagnosed as chronic periodontitis were selected for the study.

Patients chosen for the study had pocket depth ≥ 5 mm that probing pocket depth, in each of the quadrants selected for the study. A split mouth study design was used, where in each patient acted as their own control. Each side of the mouth was randomized to one of the two treatment arms. In the control site, the patient underwent thorough scaling and root planing. In the experimental site, photodynamic therapy was applied subgingivally after scaling and root planing.

Clinical parameters, namely Plaque index, Gingival index, Papillary bleeding index, Probing pocket depth, Clinical Attachment level were recorded at baseline ,1 month,3 month and 6 month.

From the results of the study the following conclusions were drawn:

Photodynamic therapy, when used along with scaling and root planing, caused more reduction in Plaque index, Gingival index, Probing pocket depth, when compared to scaling and root planing alone.

Thus it can be concluded that photodynamic therapy when used as an adjunct to scaling and root planing in the resulted in more reduction in Plaque

Index, Gingival Index, Probing Pocket Depth and Gain in Clinical Attachment Level when compared to Scaling and Root Planing alone.

Further clinical trials with standardized PDT protocol, large sample size and standardized clinical, biochemical and microbiological assessment must be undertaken, to determine the efficacy of adjunctive effect of PDT with SRP, and to establish the number of PDT applications and the interval between them that offer the best results over time.

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ANNEXURES

The Diocese of Madurai - Ramnad

C.S.I. College of Dental Sciences and Research

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ETHICAL COMMITTEE

Title of the work: Evaluation of photodynamic therapy as an adjuvant to SRP in the management of chronic periodontitis patients. A randomized clinical controlled study.

Principal investigator: Dr. Ram sundar, II MDS

Department : Periodontology **CSICDSR/IEC/0020/2016**

The request for an approval from the Institutional Ethical Committee (IEC) for the above mentioned study, submitted by the principal investigator is considered on the IEC meeting held on 08.09.2016 at CSI College of Dental Sciences and Research, Madurai. The members of the committee, the president, vice president, and the secretary are pleased to approve the proposed work mentioned above and is **'Advised to proceed with the study'**

The principal investigator and their team are directed to adhere the guidelines given below:

1. You should get detailed informed consent from the patients/participants and maintain confidentiality.
2. You should carry out the work without detrimental to regular activities as well as without extra expenditure to the Institution or Government.
3. You should inform the IEC in case of any change of study procedure, site and investigation or guide.
4. You should not deviate from the area of work for which you have applied for ethical clearance.
5. You should inform the IEC immediately in case of any adverse events or serious adverse reactions. You should abide to the rules and regulations of the institution(s).
6. You should complete the work within the specific period and if any extension of time is required, you should apply for the permission again and do the work.
7. You should submit the summary of the work to the ethical committee on completion of the work.
8. You should not claim funds from the institution while doing the work or on completion.
9. You should understand that the members of IEC have the right to monitor the work with prior intimation.
10. Your work should be carried out under the direct supervision of your Guide/Professor.

Dr.A.Charles MS MCh

President

Dr.N.Gururaj MDS

Secretary

CSI COLLEGE OF DENTAL SCIENCES AND REASERACH

DEPARTMENT OF PERIDONTOLOGY

EVALUATION OF PHOTODYNAMIC THERAPY AS AN ADJUNCT TO SRP IN THE MANAGEMENT OF CHRONIC PERIODONTITIS PATIENT A RANDOMIZED CLINICAL CONTROLLED STUDY

INFORMED CONSENT FORM / ஒப்புதல் படிவம்

NAME /பெயர்: **OP NO/ புறநோயாளி எண்:**

AGE/ வயது: **SEX/ பாலினம்:** **S.NO/ ஆராய்ச்சி செயற்கை எண்**:

ADDRESS/ முகவரி:

MOBILE NO/ அலைபேசி எண்:

I .....with my conscious agree to participate in the study.

நான் மருத்துவரின் ஆராய்ச்சி சம்பந்தப்பட்ட விவரங்களை முழுமனதுடன் மற்றும் சுயநினைவுடன் இந்த மருத்துவ ஆராய்ச்சியில் பங்குபெற சம்மதிக்கிறேன்

The doctor (DR.A.RAMSUNDAR) has clearly explained the study to me in Tamil (Local Language) and has clarified all my doubts about the study.

ஆய்வின் முழுமையான சிகிச்சையளிக்கும் திட்டத்திற்காக மருத்துவர் (அ.ராம் சுந்தர் ,ஈறு நோய் சிகிச்சை பிரிவு) அவர்களால் எனக்கு தமிழில் எளிமையாகவும், விரிவாகவும் எடுத்துரைக்கப்பட்டது. அதிலுள்ள சந்தேகங்கள் , பக்கவிளைவுகள் பற்றி கேட்கவும் எனக்கு வாய்ப்பளிக்கப்பட்டது.

I Agree to the treatment plan explained by the doctor and I give permission to take and use photographs and X rays of the my teeth, for the study; (PHOTODYNAMIC THERAPY)

நான், ஆராய்ச்சிக்காக எனது புகைப்படம், எக்ஸ்ரே, ஈறு நோய் சம்பந்தப்பட்ட நோய்களுக்கு ஈறு நோய் ஒளிக்கதிர் சிகிச்சை செய்ய மருத்துவருக்கு ஒப்புதல் அளிக்கிறேன்

I also agree to follow all the instructions given by the doctor, without fail.

நான் மருத்துவர் அளிக்கும் விதி முறைகளை தவறாமல் கடைபிடிப்பேன்

I have been given freedom to withdraw from the study, whenever from the study, whenever I wish to.

மேலும் மேற்கண்ட ஆராய்ச்சியில் பங்கு பெற முடியவில்லை என்றால் ஆராய்ச்சியிலிருந்து விலகிக்கொள்ள முழு உரிமை கொடுக்கப்பட்டுள்ளது

I declare that all the information about me are true to my knowledge.

நான் மருத்துவரின் ஆராய்ச்சி சம்பந்தப்பட்ட விவரங்களை அனைத்தையும் உண்மையான முழு மனதுடன் ஒப்புக் கொள்கிறேன்.

Patient's Signature / Thump Impression
நோயாளியின் கையொப்பம்/ பெருவிரல் ரேகை

Investigator's Signature
ஆராய்ச்சியாளரின் கையொப்பம்

Date/ தேதி :

Place/ இடம் : MADURAI/ மதுரை

CSI College of Dental Sciences and Research

DEPARTMENT OF PERIODONTOLOGY

Evaluation of Photodynamic Therapy as an adjunct to SRP in the Management of Chronic Periodontitis patients

A Randomized Clinical Controlled Study

Thesis Case Proforma

S.NO

Name: OP.NO: Date:

Age: Sex:

Address:

Phone No:

Chief Complaint:

History of Present Illness:

Past Dental History:

Medical History:

Family History:

Allergy/ Drug allergy:

Habits:

Oral Hygiene Measures:

Any Others:

Clinical Examination

I. Extra Oral Examination:

a) TMJ:
b) Lymph Nodes:
c) Facial Symmetry:
d) Lip Seal:
e) Any Other:

II. Intra Oral Examination (Hard Tissue):

A. Teeth:

1. No. of Teeth Present:
2. Occlusion:
3. Root Stumps/ Caries:
4. Crowding:
5. Stains/Restoration:
6. Faulty Restoration:
7. Wasting Disease:
8. Food Impaction (Vertical/ Horizontal):
9. Trauma From Occlusion (Fremitus Test):
10. Missing Teeth:
11. Developmental Anomalies:
12. Any Other

III. Intra Oral Examination (Soft Tissue):

I. Periodontal Status:

Gingival Status:

Maxillary:

Upper Arch	Upper Right Posterior	Upper Anterior	Upper Left Posterior
Color			
Contour			
Consistency			
Surface texture			
Size			
Position			
Exudation			
Bleeding On Probing			

Mandibular:

Lower Arch	Lower Right Posterior	Lower Anterior	Lower Left Posterior
Color			
Contour			
Consistency			
Surface texture			
Size			
Position			
Exudation			
Bleeding On Probing			

Treatment Allocation- Lot Method

Test site	Control site

CLINICAL PARAMETERS

I Plaque Index

	Baseline	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
		48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
	1 month	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
		48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
	3 month	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
		48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
	6 month	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
		48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38

II Gingival Index

	Baseline	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	1 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	3 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	6 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**

III Bleeding Index

	Baseline	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	1 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	3 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	6 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**

IV Clinical Attachment level

	Baseline	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	1 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	3 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	6 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**

V Probing Pocket Depth

	Baseline	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	1 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	3 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	6 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**

VI Gingival Recession

	Baseline	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	1 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	3 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	6 month	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
		48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**

Diagnosis :

Investigations:

Radiographic investigation: OPG

Blood Investigations:

Any other:

Date: **Staff Signature**

URKUND

Urkund Analysis Result

Analysed Document:	plegarism files.docx (D46474539)
Submitted:	1/7/2019 6:24:00 AM
Submitted By:	dr.ramsundaralagarsamy@gmail.com
Significance:	18 %